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Machine Coolant Waste Reduction by Optimizing Coolant Life

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16. ABSTRACT

Machine shops use coolants to improve the life and function of machine tools. These coolants become contaminated with oils with use, and this contamination can lead to growth of anaerobic bacteria and shortened coolant life. This project investigated methods to extend coolant life through improved coolant maintenance, with the goal of reduced volumes of coolant waste.

Skimmers to remove oil from the surface of coolants were found to be cost-effective. Use of a centrifuge was also tested. Coolant change practices were documented, and modified for improved coolant life. A specific coolant with wide applicability and tolerance was tested and found to have a life of at least seven months using the documented procedures.

This work was performed between October 1, 1986, and April 30, 1988, through the Minnesota Technical Assistance Program and the Minnesota Waste Management Board.

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MACHINE COOLANT WASTE REDUCTION BY OPTIMIZING COOLANT LIFE

by

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This study was conducted through

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FOREWORD

Today's rapidly developing and changing technologies and industrial products and practices frequently carry with them the increased generation of materials that, if improperly dealt with, can threaten both public health and the environment. The U.S. Environmental Protection Agency is charged by Congress with protecting the Nation's land, air, and water resources. Under a mandate of national environmental laws, the agency strives to formulate and implement actions leading to a compatible balance between human activities and the ability of natural systems to support and nurture life. These laws direct the EPA to perform research to define our environmental problems, measure the impacts, and search for solutions.

The Risk Reduction Engineering Laboratory is responsible for planning, implementing and managing research, development, and demonstration programs to provide an authoritative, defensible engineering basis in support of the policies, programs, and regulations of the EPA with respect to drinking water, wastewater, pesticides, toxic substances, solid and hazardous wastes, and Superfund-related activities. This publication is one of the products of that research and provides a vital communication link between the researcher and the user community.

This report provides the results from a waste minimization research project for use by small and medium sized generators of hazardous waste. The purpose of the research is to develop and promote the use of innovative technologies and management practices to reduce or eliminate the generation of hazardous wastes. Waste minimization research is seen as one key way to help small businesses improve waste management practices by reducing liability, product costs, disposal costs, and environmental, health, and safety concerns.

E. Timothy Oppelt, Director
Risk Reduction Engineering Laboratory

ABSTRACT

Machine shops use coolants to improve the life and function of machine tools. These coolants become contaminated with oils with use, and this contamination can lead to growth of anaerobic bacteria and shortened coolant life. This project investigated methods to extend coolant life through improved coolant maintenance, with the goal of reduced volumes of coolant waste.

Skimmers to remove oil from the surface of coolants were found to be cost-effective. Use of a centrifuge was also tested. Coolant change practices were documented, and modified for improved coolant life. A specific coolant with wide applicability and tolerance was tested and found to have a life of at least seven months using the documented procedures.

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Table of Contents

Page

Abstract..... iv

Tables..... vi

1. Introduction..... 1

2. Project Description..... 3

3. Conclusions and Recommendations..... 4

4. Materials

   Coolant..... 5
   Skimmers..... 6
   Centrifuge..... 7
   Waste Management Building..... 7

5. Procedures

   Baseline Sampling and Analysis..... 8
   Time-and-Motion Studies..... 9
   Ongoing Sampling and Analysis..... 9

6. Results and Discussion

   Change Practice..... 10
   Coolant Maintenance..... 10
   Centrifuge..... 12
   Blasocut 2000 Coolant..... 12
   Chip Handling..... 13

Appendices

   A - CHARACTERIZATION 14-21
   B - MONITORING & ANALYSIS - I.....22-29
   C - MONITORING & ANALYSIS - II.....30-38
   D - CONCLUSIONS & RECOMMENDATIONS.....39-42
   E - TREATABILITY.....43-45
   F - LABORATORY ANALYSIS.....46-47
   G - SOURCES OF INFORMATION.....48

TABLES

Number		Page
1	Machine tools used in Washington Scientific project.....	6
2	Changes in coolant characteristics over time.....	11

SECTION 1

INTRODUCTION

The function of a machine shop is to remove metal from stock, which may be in the form of castings, bars, extrusions, or forgings. The object of this metal removal is to create a part, which may be used as is or which may become part of an assembly. A machine is used to hold the stock (the "work") and the device doing the metal removal (the "tool"). This removal may be performed by cutting (drilling, grinding, sawing) or shearing. In the process, heat is generated by the friction between the tool and the work. A coolant, applied directly to the tool and work, is used to transfer this heat, which results in:

- Longer tool life
- Increased cutting performance
- Maintenance of dimensional stability of the work

The coolant is collected in and recirculated from a sump. After a period of time, contaminants which mix with the coolant contribute to its breakdown, at which point the coolant is replaced and disposed as waste.

The two major contaminants of coolant are chips of metal removed from the work and lubricant ("way oil"). The chips fall continuously from the work as it is processed. Most are collected using screens, conveyors, and sweeps, but some fall into the sump, from which they must be periodically removed by filtering the coolant and cleaning the sump. Way oil enters the coolant by dripping from the flat surfaces called ways which slide against each other in three axes of motion to position the work against the tool. This oil contamination ("tramp" oil) must be removed continuously or periodically using skimmers, filters, centrifuges or disposal. If chips and way oil are not removed, conditions become increasingly favorable for the growth of anaerobic bacteria. These bacteria form objectionable sulfide-containing compounds, e.g., hydrogen sulfide, and can shorten the life of the coolant by altering its chemical balance.

Coolant sumps contain from 20 to 100 gallons each and, depending on maintenance practices, the coolant may require monthly replacement. Even a small shop will have several machines, and some shops have up to 100 and more. Combine this with the use of several kinds of coolant and the disposal requirements and expense can become very burdensome. Standard waste management practice for this wastestream involves one or more of the following steps:

- Pump waste coolant into holding tanks or drums
- Skim tramp oil and segregate for energy recovery

- o Treat coolant to break oil/water emulsion
- o Separate oil and segregate for treatment/disposal
- o Treat and/or sewer remaining water

The exact management scheme is determined by the type of coolant, level of contamination, presence of regulated materials (metals, organic solvents), and availability of treatment. Disposal costs vary from $20 to $200 per 55-gallon drum depending on management required.

SECTION 2

PROJECT DESCRIPTION

Washington Scientific Industries (WSI) is a machine shop which uses a wide variety of tools to make parts from materials such as steel, aluminum, copper, and stainless steel. The machines used are medium-sized and are similar to those used in many machine shops. Waste coolant generated by WSI is contaminated with way oil and chips. Previous management of waste coolant involved the following steps:

- Monitor coolant (several types) for function and odor
- Remove coolant and clean sump (frequency variable by machine)
- Replace with new coolant
- Segregate chips for recovery as scrap
- Coolant/oil mixture collected by hauler for treatment and disposal

The volume of waste coolant generation is affected by business activity, but averages 120 55-gallon drums per year, with a management cost, including machine maintenance, handling, disposal, and replacement of $150 per drum. An extension of coolant life would result in a reduction of coolant waste generation and direct cost savings.

The project conducted under the auspices of this research grant was designed to study the follcwing:

- A specific water-soluble coolant (Blasocut 2000 Universal) in use with a variety of machines, tools, and materials
- Coolant maintenance practices associated with three types of machines
- Health effects on workers of coolant through use and handling
- Chip/coolant separation
- Oil/water separation

The aim is to identify factors and techniques which contribute to coolant life extension, and to document procedures and effects of the entire coolant life cycle. This information is seen to be useful for decision-making by other machine shops.

Machines chosen for the project are one to four years old, used for jobs with long (2-4 week) production runs. Operators, material and process were held constant as much as possible. Standard industrial engineering practices were used to determine direct and indirect labor required for coolant change practices, coolant maintenance, waste handling, and waste containment. Sampling was done to establish a baseline for new coolant, way oil, coolant dilution water, air quality, and health effects.

SECTION 3

CONCLUSIONS AND RECOMMENDATIONS

The results of tests conducted during this project indicate that it is possible to extend the life of machine tool coolant significantly and thereby reduce the volume of waste coolant generated.

It seems important to use a coolant and way oil with wide applicability and suitability for recycling. Key factors seem to be tolerance of hard water, resistance to anaerobic bacteria growth, and stability over a range of concentrations.

The project found that simple skimming of tramp oil using any of several different methods was cost-effective and reduced oil and grease concentration significantly. This proved sufficient to extend coolant life to at least seven months, when previously used coolant may have been changed as often as weekly.

While use of a single coolant is proving possible for 90% of the requirements of WSI, many machine shops may balk at changing their coolants. Further research is needed on the coolant maintenance and change practices documented in this project and their effect on the life of a variety of coolants. Research is also needed on alternate tool and work cooling methods and schemes for preventing contamination of coolant by way and haudraulic oil.

SECTION 4

MATERIALS

COOLANT AND MACHINE TOOLS

Blasocut 2000 Universal is a mineral oil based, water-soluble metal-working fluid. It is a cooling lubricant intended for use with all chip-forming operations except grinding and all materials except magnesium. The concentrate is made up of 60% refined A mineral oils, to which emulsifiers are added in the form of non-ionogenic components. This reduces the interfacial tension of oil/water phases to such a low level that a mixture yielding a fine dispersion of oil in the water is possible. Corrosion inhibitors are also added to protect the work from the effects of the water carrier fluid. No biocides are present in the concentrate, nor are any required for the maintenance of the solution. The cost of the concentrate (1985) is $9-12 per gallon, depending on packaging.

This coolant was chosen because of its applicability to a wide variety of operations and materials. It tolerates (and in fact requires) hard water as a component, and it does not contain nitrites or other materials which can adversely affect worker health. It was thought that using only one coolant in as many machines as possible would simplify the entire waste management scheme and allow for efficient coolant maintenance. The literature indicates that this coolant can be recycled extensively, thus cutting waste volumes. One of the objectives of this project was to determine the exact steps needed to accomplish this waste reduction via recycling.

The types of machine tools used are shown in Table 1.

TABLE 1. MACHINE TOOLS USED IN WASHINGTON SCIENTIFIC PROJECT.

Machine No.	Machine Type	Material Processed
1723	Lathe M Mori-Seiki	tool steel
1714	Lathe H Hitachi-Seiki	copper
3806	Broach Ohio Broach and Tool	aluminum castings
1720	Lathe O Okuma	stainless steel
4719	MMC Niigata	aluminum castings

SKIMMERS

Two disc skimmers were used, differing only in the method used to remove oil from the disc after the oil lifted from the coolant. Both cost approximately $100, and are representative of several models widely available. It is important to have proper access in order to monitor skimming activity and provide space for a receptacle to collect skimmed tramp oil. In order to use these skimmers, because of their configuration, it was necessary to modify several coolant sumps to provide the required access and mounting space. This is a very common problem with machine tools, many of which are built with totally or nearly enclosed sumps, or sumps only accessible through a secured cover.

A belt skimmer was also used in order to test a claim of a higher rate of removal of tramp oil than that possible using a disc skimmer. Because of its configuration, this skimmer was mounted as a mobile unit and tested on several machine tools. Also because of its configuration, it was possible to mount this skimmer in such a way that skimmed tramp oil drained into a 55-gallon drum, unlike the disc skimmer, which must drain into low containers that require frequent emptying. A timer was added so that the belt skimmer would run intermittently, allowing time for sufficient tramp oil to collect for efficient removal.

For all skimmers tested, it was sometimes found necessary to operate a small paddle pump in the coolant sump to create a circular surface flow and move tramp oil closer to the skimmer.

This was important to minimize the amount of coolant collected with the tramp oil. This contamination of tramp oil by coolant can lead to later disposal problems.

CENTRIFUGE

A small centrifuge was modified to function as a mobile unit. It was thought that this approach to coolant maintenance, while more costly, could sufficiently clean the coolant occasionally by removing all tramp oil, rather than relying on a continuous, partial removal. An operator was assigned to use the centrifuge to clean the coolant in 25 machine tools, a time-and-motion study was performed to track labor costs. Chips were not removed from the sump being cleaned.

WASTE MANAGEMENT BUILDING

Shortly before this project began, WSI completed construction of a building expressly for the collection and storage of chips from machine tools and for storage of solvents. In the past, many machine shops had several watertight hoppers outside their building holding chips awaiting transport to scrap dealers. More recently, these hoppers have been perforated with drain holes in order to improve the handling of scrap. However, these drainholes allow the escape of not only rainwater, but also draining coolant and oils. This could lead to groundwater contamination.

WSI addressed this problem by placing sloped floors in an enclosed building, on which rest 20 cubic yard roll-off containers. Coolant and oils drain from the chips in these containers to a trench, and from there are collected in barrels for proper disposal. Chips from the machine tools are collected in modified 55-gallon drums which can be emptied by an operator with a forklift into large carts. These carts are then also emptied by forklift into the containers in the waste management building.

SECTION 5

PROCEDURES

BASELINE SAMPLING AND ANALYSIS

In order to more accurately track any changes during the project, the first phase of the project consisted of gathering baseline data on several parameters. All sampling and analysis was performed by an independent consulting laboratory.

Coolant Water

This is tap water which is mixed with coolant concentrate to make the coolant used in the machine tools. It was found to have a pH of 7.4 and total hardness of 313 mg/l calcium carbonate. All constituents were found to be well within specifications for Blasocut 2000.

Unused Coolant

This was checked to serve as a reference against which to check recycled coolant. Analysis was made of oil and grease concentrations, bacteria plate count, and total suspended solids.

Organic Compound Scan

This test was done for both way oil and coolant. None of the 28 compounds were present at detectable levels.

Metals

Levels of arsenic, cadmium, chromium and lead in the unused way oil were not detectable.

Organic Vapors

Sampling was done in the waste management building for vapors of Stoddard solvent, 1,1,1-trichloroethane and 1,1,2-trichloro-1,2,2-trifluoroethane. These might have been expected from storage of used and unused solvents in the building, and could present a health hazard if present at elevated levels. Levels of all three were well within prescribed limits and nearly at the limits of detection.

Dermatitis

Since some coolants can cause dermatitis on operator's hands, photos were taken to document any changes during the project which might be attributable to use of recycled coolant.

TIME AND MOTION STUDIES

Using standard industrial engineering practice, time and motion studies were conducted to determine labor costs and procedures for several project study areas.

Change Practice

Operators were monitored performing standard coolant chnages on machine tools not in the study group. This was to determine the procedure used and detect any fruitful areas for study or modification during the study.

Centrifuge Use

An operator was monitored while using a mobile centrifuge to clean coolant in the sumps of 25 machine tools not in the study group. This was to determine the labor costs and procedure required for use of the centrifuge, and ultimately to determine its efficiency and applicability.

Coolant Maintenance

Operators using machine tools in the study group, and any maintenance personnel assisting them, were monitored performing selected coolant maintenance activities, but not continuously. This was done to highlight problem areas needing study or modification, determine labor costs for comparison with other methods, and document procedures.

ONGOING SAMPLING AND ANALYSIS

After coolant recycling was begun, all parameters (except dermatitis) discussed in "Baseline sampling and analysis" were resampled in five of the ensuing seven months. Photographs to document any incidence of dermatitis were not taken until the seventh month.

SECTION 6

RESULTS AND DISCUSSION

CHANGE PRACTICE

Time and motion studies established the following change practice as the most efficient for extended coolant life (former practice on right for comparison)

1) Skim all tramp oil from coolant surface
2) Pump coolant from sump
3) Vacuum chips from sump
4) Remove sump access covers
5) Vacuum chips from sump
6) Steam clean and vacuum sump (repeat until clean)
7) Replace sump access covers
8) Replace coolant

1) Pump out coolant
2) Remove easily accessible chips
3) Replace coolant

Formerly, coolant change was done as quickly as possible in order to minimize machine downtime. Problems noted included difficulty in cleaning sumps, retained oil in chips which quickly recontaminated new coolant, short coolant life (as little as one week) and frequent employee exposure to coolant and vapors. The new change practice requires an average 5.21 hours to accomplish on a cast sump. Sumps made of sheet metal take several hours less because corners are more easily cleaned.

This new coolant change practice, when combined with improved ongoing coolant maintenance, holds the promise of extending coolant life and thereby reducing waste volumes. The key factors seem to be removal of all chips and a thorough cleaning, the combination of which reduces the acceptability of the sump for the growth of anaerobic bacteria.

COOLANT MAINTENANCE

All five machine tools in the study group began the project with fresh coolant and clean sumps A 3% solution of fresh coolant was used to replace coolant lost to evaporation and that carried away on chips and work. Oil skimmers were put into operation in various modes at various time on all five coolant sumps.

After seven months, none of the coolant has required changing. Continuous operation of the disc skimmers tended to yield considerable contamination of the skimmed tramp oil by intermixed coolant. Collection of the skimmed oil from small containers proved inefficient and losses from full containers was

common. The belt skimmer, operated with a timer on a schedule of 5-10 minutes/half hour, yielded tramp oil with very little coolant contamination. In addition, the option of using a 55-gallon drum for collection of tramp oil proved superior for efficiency as well as spill control.

Table 2 summarizes changes in the key parameters over the life of the project.

TABLE 2. CHANGES IN COOLANT CHARACTERISTICS OVER TIME.

Machine No.	Date	% Coolant	Oil and Grease mg/l	Total Bacteria Plate Count, Colonies/ml	Total Suspended Solids, mg/l
1723	7/87	2.5	3,600	100,000,000	720
	9/87	4.5	20,000	71,000,000	800
	10/87	4.5	25,000	115,000,000	2100
	12/87	4.5	31,000	160,000,000	1500
	1/88	6.0	14,200	130,000,000	690
1714	7/87	2.5	4,400	3,500,000	720
	9/87	1.5	2,900	23,900,000	160
	10/87	2.0	6,200	14,400,000	1700
	12/87	2.0	27,000	45,000,000	5400
	1/88	2.0	8,400	69,000,000	8400
3806	7/87	1.0	6,600	140,000,000	1400
	9/87	2.0	43,000	93,000,000	880
	10/87	5.0	49,000	107,000,000	4000
	12/87	4.5	36,000	64,000,000	750
	1/88	4.5	12,000	167,000,000	800
4719	7/87	2.5	1,300	100,000,000	84
	9/87	4.5	25,000	78,800,000	400
	10/87	7.0	32,000	246,000,000	620
	12/87	11.0	47,000	252,000,000	3100
	1/88	10.0	20,500	310,000,000	1400
1720	7/87	2.0	2,000	130,000,000	41
	9/87	10.0	37,000	74,800,000	470
	10/87	4.5	18,000	57,000,000	360
	12/87	16.0	72,000	150,000,000	1400
	1/88	13.0	39,000	167,000,000	1100

The percent coolant remained in the stable range, and while fluctuations are seen they are not significant. In general, the oil and grease concentrations increased for most of the machines

evaluated until January 1988, when oil and grease concentrations dropped dramatically. This is the point at which skimmers were in use consistently to remove tramp oil. Other concentration drops are traceable to other, more intermittent use of skimmers. Total bacteria plate count appears to increase throughout the project, finally stabilizing roughly in the range of 150,000,000 colonies per milliliter of coolant. This is not extremely high, and, in fact, populations of 250,000,000 and more are common. Where reductions in oil and grease concentrations were observed, increases in total bacteria plate count were often observed. This is explained by noting that a reduction in oil and grease concentrations favors aerobic conditions, thus reducing the possiblity that fungal agents or anaerobic microorganisms may be present. This is extremely favorable for extended coolant life.

CENTRIFUGE

A mobile centrifuge was tested on a group of 25 machine tools not in the study group. The size of this group was determined by the length of time required to set up and operate the centrifuge: when cleaning of the 25th machine tool was completed, the first needed cleaning again. The determining factor seemed to be setting and adjusting a float in each sump which could account for fluctuating coolant levels. The entire procedure of hooking up, adjusting, and coolant cleaning required approximately one day per sump. Once running, the centrifuge performed well cleaning the coolant. Other, lingering, problems included chips plugging the intake and oil fouling the float. Overall, it seemed that use of the centrifuge to clean coolant, at least in the mobile configuration, is not efficient. The test was repeated twice, but results indicated that the capital investment could not be justified over continuous cleaning by skimming.

BLASOCUT 2000

The coolant, even after being recycled for seven months, meets or exceeds metal removal rates for aluminum, steel, copper, and stainless steel. It has shown the ability to tolerate increased concentrations of oil and grease while not yielding to increased activity of anaerobic bacteria. The use of recycled Blasocut 2000 also does not appear to be associated with any increase in adverse skin conditions or dermatitis, as supported by interviews and photographs of operators' hands.

Lab research also indicates that when the coolant must be disposed, an oil/water separation can be accomplished by lowering the pH to between 3 and 4 and allowing approximately two hours for the oil fraction to separate. The oil can then be skimmed and accumulated for disposal. Analysis indicated elevated levels of copper and zinc (2.5-3.5 mg.l copper; 8-10 mg/l zinc) in the

remaining water fraction. Disposal of this solution by sewering would require further evaluation.

CHIP HANDLING

The system for collecting and storing chips before salvage proceeds as follows:

1) Operator collects chips in 55-gallon drum mounted on dolly
2) When drum is full, it is wheeled to an aisle
3) Forklift operator empties drum into cart, segregating metals and discarding trash
4) Forklift operator empties carts into appropriate containers in waste management building

This procedure saves operator time, improves salvage quality of the chips, and collects approximately one 55-gallon drum per month of coolant and oil which drain from the collected chips. Air sampling in the waste management building indicates no misting of oil, and the highest concentrations for any of the compounds documented represent approximately 0.2% of the OSHA Permissible Exposure Limits.

Appendix A

CHARACTERIZATION

COOLANT WASTE REDUCTION PROJECT
PACE PROJECT NUMBER 870611.361
WASHINGTON SCIENTIFIC INDUSTRIES, INC.
LONG LAKE, MINNESOTA

I. INTRODUCTION

Washington Scientific Industries, Inc. is currently evaluating methods of minimizing oil/water waste generated by machine tooling operations. This investigation is being conducted under a grant from the Minnesota Technical Assistance Program (MnTAP) through the University of Minnesota. As part of this project, PACE Laboratories, Inc. (PACE) has provided sampling and analytical services to evaluate the quality of water-soluble coolants and the air quality in the waste management building at the Washington Scientific Industries (WSI) facility in Long Lake, Minnesota. In addition, a PACE industrial hygienist has conducted informal interviews with machine operators in conjunction with each sampling event.

In order to track the quality of the water-soluble metalworking coolant, analyses were performed to determine the approximate percent of coolant concentrate, the concentrations of oil and grease, total suspended solids, total bacteria (standard plate count), and concentrations of various organic compounds. The coolant chosen for this study was Blasocut 2000, produced by Blaser Swisslube, Inc.

Prior to implementation of the coolant recycling program, baseline samples of the coolant dilution water, the unused Blasocut 2000 coolant and the Mobil Vactra 2 Way Oil were collected on June 29, 1987. Since no organic compounds were found in the coolant sample, the dilution water sample was not analyzed. Air sampling in the waste management building had been performed by WSI prior to the coolant waste reduction project, therefore additional baseline air samples were not believed to be necessary.

Specific analyses performed both on the baseline samples and subsequent coolant samples were chosen for specific reasons. The approximate percent Blasocut 2000 was evaluated by refractometric methods to verify that the coolants remained in the stable range for oil/water emulsions. Please refer to Figure I, p. 29.

Oil and grease concentrations were determined since way oil used during the machining process becomes mixed with the water soluble coolant in the machine sump. Excessive oil concentrations can lead to pooling of oil on the surface of the coolant. Such a condition favors anaerobic bacteria formation. Anaerobic bacteria are associated with the production of hydrogen sulfide (H_2S), and other objectionable sulfur-containing compounds. Oil and grease analysis is also important to verify that the proper oil to water ratio is present in the coolant emulsion. Specific efforts have been focused on removing oil from the coolant sump directly. Thus, oil and grease values may vary from machine to machine.

Through the machining process, metal chips enter into the coolant reservoir. Most of these cuttings readily settle out and are transported to the waste management building for recovery of oil and coolant which have settled on the surface of the metal chips. Finer metal particles and debris may also enter into the coolant. The total suspended solids analysis determines the extent to which these finer particles may affect coolant quality.

Bacteria are present in all water-soluble metalworking coolants. It is not unusual to see a quarter of a billion bacteria colonies per milliliter (ml) of coolant. Similar quantities of bacteria are present in pasteurized milk. Specific identification of the bacteria present was not deemed necessary, since the available literature indicates that 99.9 percent of the micro-oganisms present in adequately aerated coolant are non-pathogenic.

An organic compound scan was performed on both the way oil and the coolant, to determine if any organic contaminants may have entered into the coolant.

In addition to the organic compound scan, the way oil was evaluated for various metals which may be present as additives in some petroleum oils. These compounds included arsenic, cadmium, chromium and lead.

Baseline sampling results are included in the following tables:

I-A Coolant water analysis

I-B Unused coolant sampling results

I-C Organic compound scan results

I-D Metals analysis results

I-E Organic vapor sampling results

As shown in Table I-A, the coolant dilution water has a relatively high total hardness measurement. All of the parameters shown in Table I-A are within the desirable range. The specific water soluble coolant chosen reportedly works well with hard water.

The unused coolant, as shown in Table I-B, contained approximately three percent of the coolant concentrate. The remaining parameters are shown for future reference.

As shown in Tables I-C and I-D, no metals or organic compound contaminants were found in either the Blasocut 2000 coolant or the Mobil Vactra Number 2 Way Oil.

The air quality in the waste managment building was monitored by WSI on January 9, 1987. The results were below the respective analytical detection limits for 1,1,1-trichloroethane and stoddard solvent, as measured on January 9, 1987. The only compound detected was Freon 113. The results shown on Table I-E represents less than 0.2 percent of the OSHA Permissible Exposure Limit (PEL). Please note that, based on observations made subsequent to the baseline air sampling, the parameters were changed to 1,1,1-trichloroethane and methylene chloride to reflect the materials observed in the building with the lowest PEL's.

TABLE I-A

COOLANT WATER ANALYSIS
PACE PROJECT NO. 870611.361

WASHINGTON SCIENTIFIC INDUSTRIES, INC.
LONG LAKE, MN

Sample Collected September 3, 1985

Parameter	Blaser Specifications For Water Quality	WSI Well Water Quality	Units
pH	6-7.5	7.4	
Total hardness	178-356	313	mg/L $CaCO_3$
Chloride	<20	2	mg/L
Sulfate	<20	10	mg/L
Nitrate	<10	<0.5	mg/L
Chemical O_2 demand	<20	0.5	mg $KMnO_4$/L

NOTES:

1) Analysis was performed by Culligan U.S.A.

2) "<" means less than stated value.

3) Blaser specifications are as described in papers by W. Lehmann in Technische Rundschau, 23 & 26 (1976).

TABLE I-B

UNUSED COOLANT SAMPLING RESULTS
PACE PROJECT NO. 870611.361

WASHINGTON SCIENTIFIC INDUSTRIES, INC.
LONG LAKE, MN

Sampling Date	Description	Refractometer Reading, % Coolant	Oil and Grease, mg/L	Total Bacteria Plate Count, Colonies/ml	Total Suspended Solids, mg/L
6/29/87	Unused Coolant	3.0	79	600	11

NOTES:

1) The refractometer reading was made using an Americal Optical hand-held refractometer Model No. 10440. Readings were corrected according to the calibration curve shown in Figure I.

2) "mg/L" means milligrams per liter of coolant.

3) "ml" means milliliters of coolant.

TABLE I-C

ORGANIC COMPOUND SCAN RESULTS
PACE PROJECT NO. 870611.361

WASHINGTON SCIENTIFIC INDUSTRIES, INC.
LONG LAKE, MN

Samples Collected on June 29, 1987

Parameter	Units	MDL	Concentration	
			Blasocut 2000 Coolant	Mobil Vactra 2 Way Oil
Methanol	%	0.1	ND	ND
Ethanol	%	0.1	ND	ND
Methylene chloride	%	0.1	ND	ND
Acetone	%	0.1	ND	ND
Isopropyl alcohol	%	0.1	ND	ND
n-Propanol	%	0.1	ND	ND
t-Butanol	%	0.1	ND	ND
Tetrahydrofuran	%	0.1	ND	ND
Chloroform	%	0.1	ND	ND
1,1,2-Trichloro-1,2,2,-trifluoroethane	%	0.1	ND	ND
Methyl ethyl ketone	%	0.1	ND	ND
2-Butanol	%	0.1	ND	ND
1,1,1-Trichloroethane	%	0.1	ND	ND
Ethyl acetate	%	0.1	ND	ND
1,1,2-Trichloroethane	%	0.1	ND	ND
n-Butanol	%	0.1	ND	ND
Benzene	%	0.1	ND	ND
Hexane	%	0.1	ND	ND
Cyclohexanone	%	0.1	ND	ND
Methyl Isobutyl ketone	%	0.1	ND	ND
1,1,2,2-tetrachloro-ethylene	%	0.1	ND	ND
Butyl acetate	%	0.1	ND	ND
Heptane	%	0.1	ND	ND
Toluene	%	0.1	ND	ND
Ethyl benzene	%	0.1	ND	ND
Xylenes	%	0.1	ND	ND
Total unknown peaks	%	0.1	ND	ND
High boiling compounds	%	0.1	ND	ND

NOTES: "MDL" means analytical method detection limit
"ND" means not detected at or above MDL

TABLE I-D

METALS ANALYSIS RESULTS
PACE PROJECT NO. 870611.361

WASHINGTON SCIENTIFIC INDUSTRIES, INC.
LONG LAKE, MN

Samples Collected on June 29, 1987

Parameter	Units	MDL	Mobil Vactra 2 Way Oil
Arsenic	mg/kg	0.1	ND
Cadmium	mg/kg	0.25	ND
Chromium	mg/kg	1.2	ND
Lead	mg/kg	2.5	ND

NOTES:

1) "MDL" means analytical method detection limit
2) "ND" means not detected at or above MDL

TABLE I-E

ORGANIC VAPOR SAMPLING RESULTS
WASTE MANAGEMENT BUILDING
PACE PROJECT NO. 870611.361

WASHINGTON SCIENTIFIC INDUSTRIES, INC.
LONG LAKE, MN

Samples Collected on January 9, 1987

Sample Description	Location	Sampling Time Min.	Concentration, ppm Freon 113	TCA	Stoddard Solvent
Area Sample	Floor level	60	<0.7	<1	<1
Area Sample	5 ft. height	60	1.6	<1	<1

OSHA Permissible Exposure Limits (PEL's):	1000	350	500
ACGIH Threshold Limit Values (TLV's):	1000	350	100

NOTES:
1) Samples were collected by Washington Scientific Industries, Inc. using 3M Diffusion Monitors (No. 3510) and analyzed by 3M

2) "ppm" means parts per million

3) Chemical abbreviations:
1,1,2-trichloro-1,2,2-trifluoroethane (Freon 113)
1,1,1-trichloroethane (TCA)

4) "<" means below stated value (airborne detection limit)

Appendix B

MONITORING AND ANALYSIS - I

ANALYTICAL RESULTS AND OBSERVATIONS:

July through October, 1987

The following discusses results of coolant evaluations, air sampling, and employee interviews performed on July 23, September 22 and October 15, 1987. Ongoing coolant recyling was performed from late June, 1987 through October, 1987. Subsequent sampling in December, 1987 and January, 1988 will be the subject of a subsequent report.

Samples of Blasocut 2000 coolant from five machine tools was evaluated for percent coolant, oil and grease, total bateria plate count, and total suspended solids. The unit of measurement for the coolant concentration is percent (%), the unit for oil and grease and total suspended solids concentrations is milligrams per liter of coolant liquid. Total bacteria plate count is measured in bacterial colonies per milliliter of coolant.

The results for each of these parameters is shown for three different sampling events. A separate table presents data for each of the five machine tools evaluated.

As shown in Tables II-A through II-E, the oil and grease concentration appears to have increased over time for most of the machine tools evaluated. The total bacteria plate count does not appear to be directly associated with the oil and grease concentration. The total suspended solids appear to have increased for most of the machines evaluated.

The results shown in Tables II-A through II-E appear to be normal. It should be noted that the manufacturer of the water-soluble coolant (Blaser Swisslube, Inc.) has not published criteria concentrations for oil and grease and total suspended solids, since appropriate amounts may vary with the specific application. The total bacteria plate count for all of the samples appears to be within the expected range.

The results of air sampling in the waste management building were well below the respective OSHA Permissible Exposure Limits for 1,1,1-trichloroethane and methylene chloride.

Interviews with machine operators indicated that none of the operators had experienced dermatitis since using the recycled Blasocut 2000. One employee, however, indicated that he had a history of boils on his left arm which dated back to May or June of 1987. The causative agent for this problem has not been determined.

Photographs were taken to document the baseline condition of the machine operators' hands. Subsequent photographs will be taken for the same employees in January of 1988 for comparison to determine whether any significant changes have occured.

TABLE II-A

MACHINE NO. 1723
COOLANT SAMPLING RESULTS
PACE PROJECT NO. 870611.361

WASHINGTON SCIENTIFIC INDUSTRIES, INC.
LONG LAKE, MN

Sampling Date	Description	Refractometer Reading, % Coolant	Oil and Grease, mg/L	Total Bacteria Plate Count Colonies/ml	Total Suspended Solids, mg/L
7/23/87	Recycled coolant	2.5	3,600	100,000,000	720
9/22/87	Recycled coolant	4.5	20,000	71,000,000	800
10/15/87	Recycled coolant	4.5	25,000	115,000,000	2,100

NOTES:

1) Machine No. 1723 is a Mori-Seiki unit and runs ferrous metal parts using Blasocut 2000.

2) Refractometer readings were made using an American Optical hand-held refractometer Model No. 10440. Readings corrected according to the calibration curve shown in Figure I.

3) "mg/L" means milligrams per liter of coolant.

4) "ml" means millliliters of coolant.

TABLE II-B

MACHINE NO. 1714
COOLANT SAMPLING RESULTS
PACE PROJECT NO. 870611.361

WASHINGTON SCIENTIFIC INDUSTRIES, INC.
LONG LAKE, MN

Sampling Date	Description	Refractometer Reading, % Coolant	Oil and Grease, mg/L	Total Bacteria Plate Count, Colonies/ml	Total Suspended Solids, mg/L
7/23/87	Recycled Coolant	2.5	4,400	3,500,000	720
9/22/87	Recycled Coolant	1.5	2,900	23,900,000	160
10/15/87	Recycled Coolant	2.0	6,200	14,400,000	1,700

NOTES:
1) Machine No. 1714 is a Hitachi-Seiki unit and runs low-carbon steel and copper parts using Blasocut 2000.

2) Refractometer Readings were made using an American Optical hand-held refractometer, Model No. 10440. Readings were corrected according to the calibration curve shown in Figure I.

3) "mg/L" means milligrams per liter of coolant.

4) The coolant in Machine 1714 was last changed in June, 1987.

5) "ml" means milliliters of coolant.

TABLE II-C

MACHINE NO. 3806
COOLANT SAMPLING RESULTS
PACE PROJECT NO. 870611.361

WASHINGTON SCIENTIFIC INDUSTRIES, INC.
LONG LAKE, MN

Sampling Date	Description	Refractometer Reading, % Coolant	Oil and Grease, mg/L	Total Bacteria Plate Count, Colonies/ml	Total Suspended Solids, mg/L
7/23/87	Recycled Coolant	1.0	6,600	140,000,000	1,400
9/22/87	See Note (4)	2.0	43,000	93,000,000	880
10/15/87	Recycled Coolant	5.0	49,000	107,000,000	4,000

NOTES:
1) Machine No. 3806 is an Ohio Broach and Tool unit and runs aluminum parts using Blasocut 2000.

2) Refractometer readings were made using an American Optical hand-held refractometer, Model No. 10440. Readings were corrected according to the calibration curve shown in Figure I.

3) "mg/L" means milligrams per liter of coolant.

4) Fresh coolant was added to reservoir on September 21, 1987 but none was removed.

5) "ml" means milliliters of coolant

TABLE II-D

MACHINE NO. 4719
COOLANT SAMPLING RESULTS
PACE PROJECT NO. 870611.361

WASHINGTON SCIENTIFIC INDUSTRIES, INC.
LONG LAKE, MN

Sampling Date	Description	Refractometer Reading, % Coolant	Oil and Grease mg/L	Total Bacteria Plate Count, Colonies/ml	Total Suspended Solids, mg/L
7/23/87	Recycled Coolant	2.5	1,300	100,000,000	84
9/22/87	Recycled Coolant	4.5	25,000	78,800,000	400
10/15/87	Recycled Coolant	7	32,000	246,000,000	620

NOTES: 1) Machine No. 4719 is a Niigata unit and runs aluminum parts using Blasocut 2000.

2) Refractometer Readings were made using an American Optical hand-held refractometer, Model No. 10440. Readings were corrected according to the calibration curve shown in Figure I.

3) "mg/L" means milligrams per liter of coolant.

4) "ml" means millliliters of coolant.

TABLE II-E

MACHINE NO. 1720
COOLANT SAMPLING RESULTS
PACE PROJECT NO. 870611.361

WASHINGTON SCIENTIFIC INDUSTRIES, INC.
LONG LAKE, MN

Sampling Date	Description	Refractometer Reading, % Coolant	Oil and Grease mg/L	Total Bacteria Plate Count, Colonies/ml	Total Suspended Solids, mg/L
7/23/87	Recycled Coolant	2.0	2,000	130,000,000	41
9/22/87	Recycled Coolant	10	37,000	74,800,000	470
10/15/87	Recycled Coolant	4.5	18,000	57,000,000	360

NOTES: 1) Machine No. 1720 is an Okuma unit and runs stainless steel and aluminum parts (pods) using Blasocut 2000.

2) Refractometer readings were made using an American Optical hand-held refractometer, Model No. 10440. Readings were corrected according to the calibration curve shown in Figure I.

3) "mg/L" means milligrams per liter of coolant.

TABLE II-F

MACHINE NO. 1714 COOLANT
ORGANIC COMPOUND SCAN RESULTS
PACE PROJECT NO. 870611.361

WASHINGTON SCIENTIFIC INDUSTRIES, INC.
LONG LAKE, MN

Parameter	Units	MDL	Concentration 7-23-87	9-23-87	10-15-87
Methanol	%	0.1	ND	ND	ND
Ethanol	%	0.1	ND	ND	ND
Methylene chloride	%	0.1	ND	ND	ND
Acetone	%	0.1	ND	ND	ND
Isopropyl alcohol	%	0.1	ND	ND	ND
n-Propanol	%	0.1	ND	ND	ND
t-Butanol	%	0.1	ND	ND	ND
Tetrahydrofuran	%	0.1	ND	ND	ND
Chloroform	%	0.1	ND	ND	ND
1,1,2-Trichloro 1,2,2,-trifluoroethane	%	0.1	ND	ND	ND
Methyl ethyl ketone	%	0.1	ND	ND	ND
2-Butanol	%	0.1	ND	ND	ND
1,1,1-Trichloroethane	%	0.1	ND	ND	ND
Ethyl acetate	%	0.1	ND	ND	ND
1,1,2-Trichloroethane	%	0.1	ND	ND	ND
n-Butanol	%	0.1	ND	ND	ND
Benzene	%	0.1	ND	ND	ND
Hexane	%	0.1	ND	ND	ND
Cyclohexanone	%	0.1	ND	ND	ND
Methyl isobutyl ketone	%	0.1	ND	ND	ND
1,1,2,2-tetrachloro-ethylene	%	0.1	ND	ND	ND
Butyl acetate	%	0.1	ND	ND	ND
Heptane	%	0.1	ND	ND	ND
Toluene	%	0.1	ND	ND	ND
Ethyl benzene	%	0.1	ND	ND	ND
Xylenes	%	0.1	ND	ND	ND
Total unknown peaks	%	0.1	ND	ND	ND
High boiling compounds	%	0.1	ND	ND	1.7±0.3

NOTES: "MDL" means analytical method detection limit
"ND" means not detected at or above MDL

TABLE II-G

ORGANIC VAPOR SAMPLING RESULTS
WASTE MANAGEMENT BUILDING
PACE PROJECT NO. 870611.361

WASHINGTON SCIENTIFIC INDUSTRIES, INC.
LONG LAKE, MN

Sampling Date	Location	Sampling Period	Concentration, ppm TCA	$MeCl_2$
7/24/87	5 ft. from S. Wall 20 ft. from W. Wall 5.5 ft. height	1410-1552	<0.01	<0.02
9/22/87	5 ft. from S. Wall 20 ft. from W. Wall 5.5 ft. height	1515-1654	0.08	0.07
OSHA Permissible Exposure Limits (PEL's):			350	500
ACGIH Threshold Limit Values (TLV's):			350	100

NOTES: 1) Samples were collected by PACE Laboratories, Inc.(PACE) personnel.

2) "ppm" means parts per million.

3) Chemical abbreviations:
1,1,1-Trichloroethane (TCA)
Methylene Chloride ($MeCl_2$)

4) "<"means less than stated value (airborne detection limit)

5) No air sample was collected on 10-15-87.

ANALYTICAL RESULTS AND OBSERVATIONS

December 1987 through January 1988

Samples of Blasocut 2000 coolant from five machine tools were evaluated for percent coolant, oil and grease, total bacteria plate count and suspended solids. The unit for coolant concentration is percent (%). The unit for oil and grease and total suspended solids is milligrams per liter of coolant (mg/L). Total bacteria plate count results are reported in (bacterial) colonies per milliliter (ml) of coolant.

The results for each of these parameters is shown for the last two sampling events performed on December 17, 1987 and January 22, 1988. A separate table presents data for each of the five machine tools evaluated. The results of previous sampling events are shown in Section II.

As shown in Tables II-A through II-E and III-A through III-E, the oil and grease concentrations appear to have increased significantly from July 1987 to January 1988. The results of coolant analysis on samples collected in January 1988 indicated a decrease in oil and grease concentrations when compared to results from October and December, 1987.

The most significant reduction in oil and grease concentrations was observed for Machine No. 3806. The measured oil and grease concentrations on the recycled coolant sample collected on January 22, 1988 was 12,000 mg/L compared to a high of 49,000 mg/L measured in October, 1987. In November of 1987, a proprietary belt-type oil skimmer was installed at Machine No. 3806 (Master Chemical Corporation "Scrounger" brand oil skimmer). The use of this oil skimmer appears to have been accompanied by a significant decrease in the oil and grease concentration and a similar decrease in total suspended solids.

Percent coolant concentrations remained relatively steady throughout the survey. Only the recycled coolant from Machine No. 1720 showed a general increase in coolant concentrations from July, 1987 to January, 1988, with wide fluctuations. All of the percent coolant measurements were well within the stable coolant range, as shown in Figure I.

Total bacteria plate count results tended to increase with successive sampling events. The results, however, are in the range that is expected, according to available literature on water-soluble cutting fluids.

The total suspended solids results increased for several of the machine tools evaluated, with a decrease noted for most of the machine tools between the December and January sampling events. The most significant decrease, as discussed above, was for Machine No. 3806.

Results of informal interviews conducted with machine operators did not reveal any work-related skin disorders since using the recycled Blasocut 2000. Photographs were taken in January, 1988 to document the condition of machinists hands after seven months of handling recycled coolant. No changes were noted in comparing baseline photographs with photographs taken on January 22, 1988.

The results of air sampling in the waste management building were well below the respective OHSA Permissible Exposure Limits for 1,1,1-trichloroethane and methylene chloride. Most of the air sampling results were below the analytical detection limit for these compounds.

TABLE III-A

MACHINE NO. 1723
COOLANT SAMPLING RESULTS
PACE PROJECT NO. 870611.361

WASHINGTON SCIENTIFIC INDUSTRIES, INC.
LONG LAKE, MN

Sampling Date	Description	Refractometer Reading, % Coolant	Oil and Grease, mg/L	Total Bacteria Plate Count, Colonies/ml	Total Suspended Solids, mg/L
12/17/87	Recycled Coolant	4.5	31,000	160,000,000	1,500
11/22/88	Recycled Coolant	6.0	14,200	130,000,000	690

NOTES: 1) Machine No. 1723 is a Mori-Seiki unit and runs ferrous metal parts using Blasocut 2000.

2) Refractometer readings were made using an American Optical hand-held refractometer, Model No. 10440. Readings were corrected according to the calibration curve shown in Figure I.

3) "mg/L" means milligrams per liter of coolant.

4) "ml" means millliliters of coolant

TABLE III-B

MACHINE NO. 1714
COOLANT SAMPLING RESULTS
PACE PROJECT NO. 870611.361

WASHINGTON SCIENTIFIC INDUSTRIES, INC.
LONG LAKE, MN

Sampling Date	Description	Refractometer Reading, % Coolant	Oil and Grease, mg/L	Total Bacteria Plate Count, Colonies/ml	Total Suspended Solids, mg/L
12/17/87	Recycled Coolant	2.0	27,000	45,000,000	5,400
1/22/88	Recycled Coolant	2.0	8,400	69,000,000	8,400

NOTES:
1) Machine No. 1714 is a Hitachi-Seiki unit and runs low carbon steel and copper parts using Blasocut 2000.

2) Refractometer Readings were made using an American Optical hand-held refractometer, Model No. 10440. Readings were corrected according to the calibration curve shown in Figure I.

3) "mg/L" means milligrams per liter of coolant.

4) "ml" means millliliters of coolant.

5) The coolant in Machine 1714 was last changed in June, 1987.

TABLE III-C

MACHINE NO. 3806
COOLANT SAMPLING RESULTS
PACE PROJECT NO. 870611.361

WASHINGTON SCIENTIFIC INDUSTRIES, INC.
LONG LAKE, MN

Sampling Date	Description	Refractometer Reading, % Coolant	Oil and Grease, mg/L	Total Bacteria Plate Count, Colonies/ml	Total Suspended Solids, mg/L
12/17/87	Recycled Coolant	4.5	36,000	64,000,000	750
1/22/88	Recycled Coolant	4.5	12,000	167,000,000	800

NOTES:
1) Machine No. 3806 is an Ohio Broach and Tool unit and runs aluminum parts using Blasocut 2000.

2) Refractometer readings were made using an American Optical hand-held refractometer, Model No. 10440. Readings were corrected according to the calibration curve shown in Figure I.

3) "mg/L" means milligrams per liter of coolant.

4) "ml" means milliliters of coolant.

5) Fresh coolant was added to Machine 3806 on September 21, 1987.

TABLE III-D

MACHINE NO. 4719
COOLANT SAMPLING RESULTS
PACE PROJECT NO. 870611.361

WASHINGTON SCIENTIFIC INDUSTRIES, INC.
LONG LAKE, MN

Sampling Date	Description	Refractometer Reading, % Coolant	Oil and Grease, mg/L	Total Bacteria Plate Count, Colonies/ml	Total Suspended Solids, mg/L
12/17/87	Recycled Coolant	11	47,000	252,000,000	3,100
1/22/88	Recycled Coolant	10	20,500	310,000,000	1,400

NOTES: 1) Machine No. 4719 is a Niigata unit and runs aluminum parts using Blasocut 2000.

2) Refractometer readings were made using an American Optical hand-held refractometer, Model No. 10440. Readings were corrected according to the calibration curve shown in Figure I.

3) "mg/L" means milligrams per liter of coolant.

4) "ml" means milliliters of coolant.

TABLE III-E

MACHINE NO. 1720
COOLANT SAMPLING RESULTS
PACE PROJECT NO. 870611.361

WASHINGTON SCIENTIFIC INDUSTRIES, INC.
LONG LAKE, MN

Sampling Date	Description	Refractometer Reading, % Coolant	Oil and Grease, mg/L	Total Bacteria Plate Count, Colonies/ml	Total Suspended Solids, mg/L
12/17/87	Recycled Coolant	16	72,000	150,000,000	1,400
1/22/88	Recycled Coolant	13	39,000	167,000,000	1,100

NOTES: 1) Machine No. 1720 is an Okuma unit and runs stainless steel and aluminum parts (pods) using Blasocut 2000.

2) Refractometer readings were made using an American Optical hand-held refractometer, Model No. 10440. Readings were corrected according to the calibration curve shown in Figure I.

3) "mg/L" means milligrams per liter of coolant.

4) "ml" means millliliters of coolant.

TABLE III-F

MACHINE NO. 1714 COOLANT
PACE PROJECT NO. 870611.361

WASHINGTON SCIENTIFIC INDUSTRIES, INC.
LONG LAKE, MN

Parameter	Units	MDL	Concentration 1/17/87	Concentration 1/22/88
Methanol	%	0.1	ND	ND
Ethanol	%	0.1	ND	ND
Methylene chloride	%	0.1	ND	ND
Acetone	%	0.1	ND	ND
Isopropyl alcohol	%	0.1	ND	ND
n-Propanol	%	0.1	ND	ND
t-Butanol	%	0.1	ND	ND
Tetrahydrofuran	%	0.1	ND	ND
Chloroform	%	0.1	ND	ND
1,1,2-Trichloro-1,2,2,-trifluoroethane	%	0.1	ND	ND
Methyl ethyl ketone	%	0.1	ND	ND
2-Butanol	%	0.1	ND	ND
1,1,1-Trichloroethane	%	0.1	ND	ND
Ethyl acetate	%	0.1	ND	ND
1,1,2-Trichloroethane	%	0.1	ND	ND
n-Butanol	%	0.1	ND	ND
Benzene	%	0.1	ND	ND
Hexane	%	0.1	ND	ND
Cyclohexanone	%	0.1	ND	ND
Methyl isobutyl ketone	%	0.1	ND	ND
1,1,2,2-tetrachloro-ethylene	%	0.1	ND	ND
Butyl acetate	%	0.1	ND	ND
Heptane	%	0.1	ND	ND
Toluene	%	0.1	ND	ND
Ethyl benzene	%	0.1	ND	ND
Xylenes	%	0.1	ND	ND
Total unknown peaks	%	0.1	ND	ND

NOTES: "MDL" means analytical method detection limit
"ND" means not detected at or above MDL

TABLE III-G

ORGANIC VAPOR SAMPLING RESULTS
WASTE MANAGEMENT BUILDING
PACE PROJECT NO. 870611.361

WASHINGTON SCIENTIFIC INDUSTRIES, INC.
LONG LAKE, MN

Samples Collected on January 9, 1987

Sampling Date	Location	Sampling Period	Concentration, ppm TCA	$MeCl_2$
12/17/87	On S. wall 20 ft. from W. wall 6 ft. height	1411-1527	<0.01	<0.03
1/22/88	On S. wall 20 ft. from W. wall 6 ft. height	1422-1556	<0.02	<0.03

OSHA Permissible Exposure Limits (PEL's):	350	500
ACGIH Threshold Limit Values (TLV's):	350	100

NOTES:
1) Samples were collected by PACE Laboratories, Inc. (PACE) personnel.
2) "ppm" means parts per million
3) Chemical abbreviations:
1,1,1-Trichloroethane (TCA)
Methylene Chloride ($MeCl_2$)
4) "<" means below stated value (airborne detection limit).

APPENDIX D

CONCLUSIONS AND RECOMMENDATIONS

Recycled Coolant Quality - As was discussed in Sections II and III, the percent coolant remained in the stable range, according to Figure I, attached. The fluctuations in percent coolant throughout the project were not significant. The measured percent coolant values in some of the machine tools were consistently higher. This difference between different machines, however, was not associated with any significant differences in the other parameters.

In general, the oil and grease concentrations increased for most of the machines evaluated. The oil and grease concentrations appear to be manageable in that significant reductions were noted for Machine No. 3806 while using a Scrounger brand motorized belt-type skimmer. The skimmer appears to be adaptable for use at the source. Unfortunately, the effectiveness of the skimmer was only evaluated at Machine No. 3806 during this survey. A portable skimmer connected to a waste oil drum was being investigated, but was not in use as of January, 1988.

Total bacteria plate count results appeared to increase throughout the project. Most of the bacteria counts stabilized in the range of one hundred and fifty million (150,000,000) colonies per milliliter of coolant. Where oil and grease concentration reductions were observed, increases in total bacteria plate count were often observed. A reduction in oil and grease concentrations favors aerobic conditions, thus reducing the probability that fungal agents or anaerobic microorganisms may be present. As was discussed in Section I, anaerobic bacteria and fungi are associated with the production of hydrogen sulfide (H_2S), which is often described as a "rotten egg" odor. During normal operation, none of the machines were associated with an objectionable odor. Several machinists noted that machines which had not been used for over forty eight (48) hours often did produce an objectionable odor, due to the fact that the coolant was not adequately aerated as it would be during normal operation.

Total suspended solid concentrations increased, overall. Some reductions in total suspended solids were observed, such as in the case of Machine No. 3806, which was equipped with a motorized belt-type skimmer. In addition to reducing the oil and grease concentration in the recycled coolant at this machine, the skimmer was also able to remove a significant percentage of metal chips and other solids. It was believed that additional reductions in total suspended solid concentrations could be achieved through the use of a centrifuge. Preliminary tests using a centrifuge were performed by Washington Scientific Industries for several months, but met with limited success. No additional testing using the centrifuge is planned.

Occupational Health Considerations - Dermal Exposure - Informal interviews conducted with machinists operating all of the machine tools evaluated during this project reported that they experienced no skin disorders during the period from July, 1987 through January, 1988. One individual had reported

experiencing boils. This particular skin disorder, however, existed before the inception of the coolant recycling project. The origin of this particular problem has not been determined.

Comparison of baseline photographs of machinists and forearms with photographs taken on January 22, 1988 yielded no observable changes.

Based on these observations, the use of recycled Blasocut 2000 coolant does not appear to be associated with any increase in adverse skin conditions or dermatitis. Most of the machinists interviewed worked at several different machines, but used Blasocut 2000 most or all of the time that they were operating machine tools.

The only history of dermatitis reported by the machinists interviewed pre-dated the use of Blasocut 2000 and was usually associated with oil-based (non-water soluble) metal working fluids. Some oil-based cutting fluids are still in use, to a lesser degree. Dermal exposure to oil-based cutting fluids and to oil and grease which has accumulated in water soluble cutting fluids could potentially produce an acne-type dermatitis known as folliculitis. Control of the oil and grease concentrations in the recycled coolant will minimize the possibility of machinists developing this type of skin disorder. Frequent washing of the hands and forearms was practiced by most of the machinists interviewed. It is not believed that protective gloves are necessary when using water-soluble coolants, but they would further reduce the possibility of dermatitis.

Other potential skin irritants, besides the presence of oils and greases, include bacteria, fungi and metal particulates. The presence of bacteria in the water soluble coolants does not, in itself, indicate a significant problem. As has been indicated before, greater than ninety-nine percent (99%) of the aerobic bacteria present in well-aerated coolants are non-pathogenic. The presence of bacteria in the concentrations shown in the attached tables should not produce any adverse health effects. These concentrations of aerobic bacteria compete with fungal populations and populations of anaerobic bacteria, both of which are associated with the production of objectionable odors and which may produce bacterial or fungal infections. Although the bacteria present in the recycled coolants is believed to be non-pathogenic, adequate personal hygiene must be maintained to prevent accidental ingestion of these bacteria.

The operations in the waste management building are believed to require the use of protective gloves which are impervious to solvents and oils. The use of gloves is necessary because of the need to handle more non-water soluble oils, waste oils, and waste solvents, such as 1,1,1-trichloroethane and methylene chloride.

Occupational Health Considerations - Inhalation Exposure - During normal machining operations, no significant misting of the cutting fluids was observed. Since no OSHA or NIOSH validated sampling method exists for

water-soluble cutting fluids, the mist concentrations were not evaluated. Most of the mist which is generated is trapped and recovered in the machine tool, itself, since the machine door is closed during machining. The concentrations of insoluble oil in the recycled coolant are generally below four percent (4%), by weight. Since the OSHA Permissable Exposure Limit (PEL) for oil mist exposure is five milligrams per cubic meter of air (mg/m^3), the total mist exposure would have to be in excess of 100 mg/m^3. Airborne mist concentrations of 5 mg/m^3 usually produce visible emissions, based on the experience of the investigator. No oil mist was visible outside of the machine tools, thus, oil mist exposures are not believed to be detectable in air.

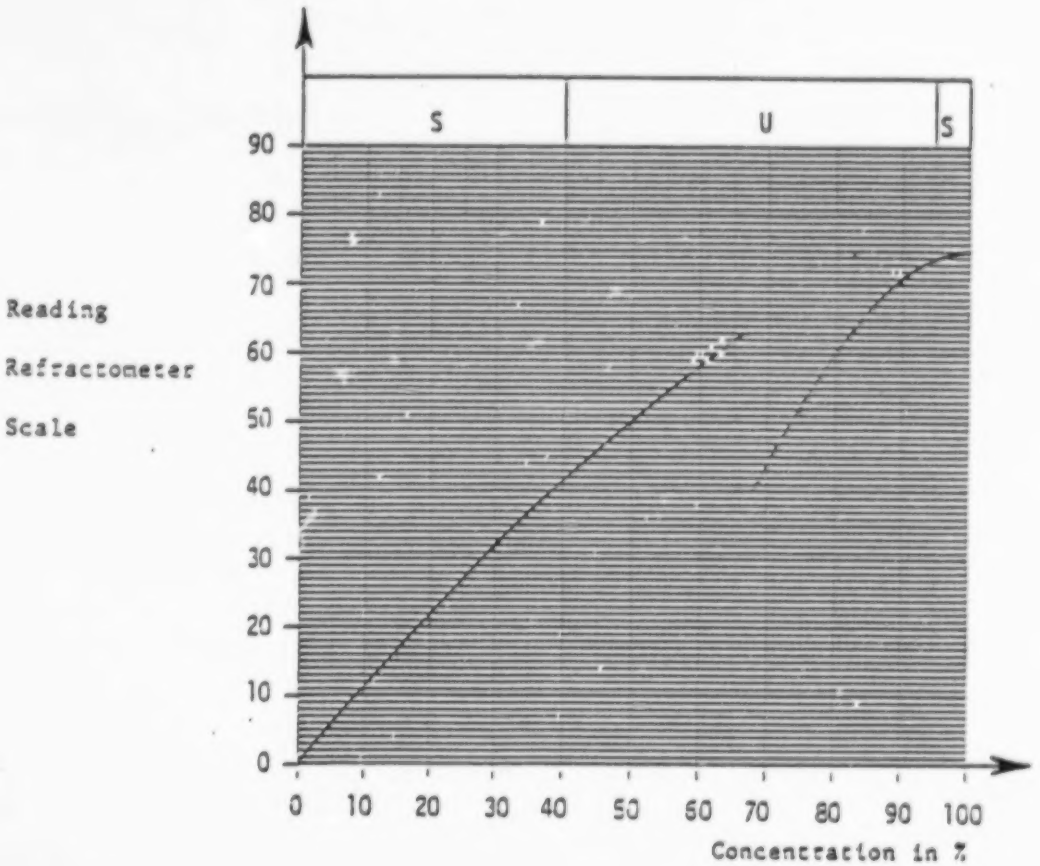
The operations performed in the waste management building are not believed to produce any significant misting of oil. The only measured airborne contaminants were 1,1,1-trichloroethane, methylene chloride and 1,1,2-trichloro-1,2,2,-trifluoroethane (Freon 113), as shown in I-E, II-G and III-G. The highest concentrations for any of the compounds documented in the waste management building represent approximately 0.2% of the PEL for the compounds evaluated.

Waste Coolant Treatment - Although Blasocut 2000 water-soluble metal working fluid was successfully recycled for a period of over seven months, ultimately, some coolant waste is inevitable. Enclosed in Appendix A are results of an evaluation of four treatment protocols for water-soluble coolant waste.

As is discussed in the attached Appendix, these protocols were successful in reducing the oil and grease concentrations of the waste coolant. Oil and grease and other specific parameters were evaluated before and after treatment and are presented in the attached report. Oil and grease was the only parameter which was significantly reduced by treatment. However, all of the relevant parameter results were below the applicable discharge limits, based on past monitoring reports and assuming a daily discharge of 100 gallons of treated coolant. The actual daily discharge of treated Blasocut 2000 has not been determined, but is expected to be far below 100 gallons.

BLASOCUT 2000 Universal

Correction table to determine concentration reading with refractometer. The scale is based on measuring temperature of 20° C or 68° F.



S = Stable range of emulsion
U = Unstable range of emulsion

Note: In the range of 60 and 95 % concentration a double refraction can be detected.

FIGURE I
REFRACTOMETER CALIBRATION CHART
BLASOCUT 2000

pace laboratories, inc.
PROFESSIONAL ANALYTICAL CHEMISTRY & ENGINEERING

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Minneapolis, Minnesota
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March 11, 1988

Mr. Joseph Pallansch
Washington Scientific Industries, Inc.
2605 West Wayzata Boulevard
P.O. Box 340
Long Lake, MN 55356

Re: Sewer Discharge of Used Machining Coolant
PACE Project No. 880119.200

Dear Mr. Pallansch:

We are writing to provide results of treatability tests performed on a sample of your waste water-soluble coolant. The tests were performed to evaluate the effectiveness of several treatment methods based on the wastewater discharge limitations applicable at your Long Lake, Minnesota facility. This letter will describe each treatment method, present the results of treatment and recommend disposal procedures.

Treatment Methods

Four treatment methods were tested for their ability to reduce oil and grease, chemical oxygen demand and metals from a coolant sample. Each treatment was performed from a portion of the same coolant sample. Table 1 provides a description of the treatment procedures studied. After oil removal, the treated samples were analyzed for metals, oil and grease and total suspended solids.

Results of Treatment

Analytical results of the treatment study are shown in the laboratory report provided as Attachment A. The results characterize the untreated sample as well as each treated solution. The results show that the untreated sample contained high concentrations of chemical oxygen demand, biochemical oxygen demand, oil and grease and total suspended solids. In addition, the untreated sample contained copper and zinc at levels above Federal Metal Finishing discharge limitations.

Results of the treated samples show that metals concentrations remained above Metal Finishing limitations in all of the samples. Although poor metals removal was obtained the treatment methods can be compared in terms of oil and grease removal. As shown on the laboratory report the best reduction in oil and grease was found in the Alum and Calcium treated samples. Please note that the Calcium treatment method is much simpler than the Alum method.

Mr. Joseph Pallansch
Washington Scientific Industries, Inc.

Facility Discharge Considerations

Based on the poor metals treatment results facility discharge monitoring reports were reviewed to determine if the waste coolant would be suitable for sewer discharge. From the monitoring information you supplied an average process discharge volume and average metals concentrations were used to calculate the addition of 100 gallons of waste coolant to the daily discharge. From this calculation the composite discharge metals concentrations were well within MWCC and Federal Metal Finishing limitations. Also we do not expect a significant increase in strength charge associated with an infrequent discharge of 100 gallons of the waste coolant.

Summary and Recommendations

The treatment methods investigated were ineffective in removing regulated metals from the waste coolant. However, based on a review of facility discharge monitoring reports a daily discharge of approximately 100 gallons would be suitable for sewer discharge. We recommend that the waste coolant is discharged to the sewer after removal of metal fines and oil separation. Gravity oil separation would be adequate for sewer discharge, however, the calcium treatment method could be used to enhance oil removal.

If you have any questions concerning this report, please do not hesitate to contact me.

Sincerely,

James A. Postiglione

James A. Postiglione, P.E.
Project Engineer

JAP/jb

TABLE 1

DESCRIPTION OF TREATMENT PROCEDURES
WASHINGTON SCIENTIFIC INC. WASTE COOLANT TREATMENT

PACE Laboratories, Inc. March 11, 1988

Step	Acid Treatment	Alum Treatment	Calcium Treatment	Iron Treatment
1	Add sulfuric acid until a pH between 3 to 4 is reached; approximately 0.4 gallons per 100 gallons of waste coolant.	Add sulfuric acid until a pH between 3 to 4 is reached, approximately 0.4 gallons per 100 gallons of waste coolant.	Add approximately 1.5 pounds of calcium chloride per 100 gallons of waste coolant.	Add approximately 1.2 pounds of ferrous hydroxide ammonium sulfate per 100 gallons of waste coolant.
2	Add approximately 0.15 pounds of aluminum sulfate per 100 gallons of waste coolant.	Allow approximately 2 hours for gravity oil separation.	Mix for 30 minutes.	Mix for 15 to 30 minutes.
3	Mix for 30 minutes	Skim off oil	Allow approximately 2 hours for gravity oil separation	Add sulfuric acid until a pH below 5 is reached; approximately 0.15 gallons per 100 gallons of waste coolant.
4	Allow approximately 2 hours for gravity oil separation.	Drain supernatent to sewer.	Skim off oil.	Raise pH with lime; approximately 1.8 pounds per 100 gallons of waste coolant.
5	Skim off oil		Drain supernatent to sewer.	Allow approximately 2 hours for gravity oil separation
6	Add sodium hydroxide to raise pH to 7: approximately 0.7 pounds per 100 gallons of waste coolant.			Skim off oil.
7	Drain supernatent to sewer.			Drain supernatent to sewer.

pace laboratories, inc

REPORT OF LABORATORY ANALYSIS

Offices:
Minneapolis, Minnesota
Tampa, Florida
Coralville, Iowa

Washington Scientific Industries, Inc.
2605 West Hayzata Blvd.
P.O. Box 340
Long Lake, MN 55356

March 11, 1988
PACE Project Number: 880208506

Attn: Mr. Joe Pallansch

Date Sample(s) Collected: 02/08/88
Date Sample(s) Received: 02/08/88

PACE Sample Number:			029420	029430	029440
Parameter	Units	MDL	Coolant Mach. No. 1714	Acid Treated Coolant	Alum. Treated Coolant
Biochemical Oxygen Demand	mg/L	60	25000	-	-
Chemical Oxygen Demand	mg/L	50	31500	-	-
Chromium	mg/L	0.05	0.35	0.12	0.16
Copper	mg/L	0.01	6.7	5.5	5.5
Lead	mg/L	0.1	0.1	0.3	0.4
Nickel	mg/L	0.05	ND	0.10	0.22
Oil and Grease	mg/L	1	3800	480	200
Solids, Total Suspended	mg/L	1	1600	150	130
Zinc	mg/L	0.10	34	29	31

MDL Method Detection Limit
ND Not detected at or above the MDL.

pace laboratories, inc.

REPORT OF LABORATORY ANALYSIS

Offices:
Minneapolis, Minnesota
Tampa, Florida
Coralville, Iowa

Mr. Joe Pallansch
Page 2

March 11, 1988
PACE Project Number: 880208506

PACE Sample Number:			029450	029460
			Calcium Treated	Iron Treated
Parameter	Units	MDL	Coolant	Coolant
Chemical Oxygen Demand	mg/L	50	-	15400
Chromium	mg/L	0.05	0.18	0.07
Copper	mg/L	0.01	3.4	2.5
Lead	mg/L	0.1	1.5	0.3
Nickel	mg/L	0.05	0.43	0.14
Oil and Grease	mg/L	1	260	370
Solids, Total Suspended	mg/L	1	880	510
Zinc	mg/L	0.10	9.8	8.3

MDL Method Detection Limit

The data contained in this report were obtained using EPA or other approved methodologies. All analysis were performed by me or under my direct supervision.

Thomas L. Halverson
Inorganic Chemistry Manager

APPENDIX G

SOURCES OF INFORMATION

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